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BARK PHOTOSYNTHESIS IN OCOTILLO

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Ocotillo (*Fouquieria splendens* Engelm.) is a unique plant of the Sonoran Desert in respect to its physiology and candelabra growth form. The rapidity of leaf development following an increase in soil moisture after a drought period has been the object of numerous investigations. In only a few days after rain, leaves may fully develop on bare stems (Cannon, 1905). The problem of survival during extensive drought periods has been studied also. As early as 1905, Cannon noted that, "Although seemingly lifeless during the drought the plant is not dormant, since beneath its gray exterior there is a chlorophyllous bearing tissue which enables the photosynthetic process to go on, even if in a feeble manner . . ." Later, Scott (1932) described the anatomy of this bark chlorenchyma and noted its association with water storage cells and leaf primordia.

The objective of this study was to determine if bark chlorophyllous tissue contributes to the photosynthetic economy of this plant. Bark photosynthesis during leafless periods could be of adaptive significance in respect to extended drought tolerance and might also be involved in the rapidity of ephemeral leaf production.

Photosynthesis and respiration measurements were made in the field on portions of stems of two mature plants growing in Deep Canyon near Palm Desert, California.[1] Measurements were made when the plants were in full leaf in March and when leafless subsequent to drought in May. A cylindrical double-walled plexiglass chamber was placed on the stem and sealed at both ends (fig. 1). Air temperature within the chamber was controlled by water flowing through the jacket from a constant temperature bath. The CO_2 content of air passing through the chamber, and of free air, was determined with a Beckman model 15A infrared gas analyzer. Air flow rate was maintained at 120 liters per hour.

When the plants were in leaf, measurements were made in the light and in a darkened chamber. Then, all leaves were removed and addi-

[1] We would like to express our appreciation to Lloyd P. Tevis for information relevant to ocotillo behavior in Deep Canyon as well as the personnel of the Philip L. Boyd Desert Research Center for assistance and the use of facilities.

FIG. 1. Photosynthesis chamber on ocotillo stem.

tional measurements were made on the leafless stem in light and dark. Measurements were performed also on the leafless stems subsequent to natural leaf loss.

Additional measurements were made in the laboratory on a potted transplant which had been in a gallon container for over a year prior to use in the study. As in the field, measurements were made when the plant was in leaf; when the leaves had been hand-removed; and when leafless subsequent to drought.

All measurements were performed at chamber temperatures between 20–25°C and at light intensities parallel to the chamber between 4000 to 6000 foot candles.

The results of measurements on all plants are shown in Table 1. The figures represent apparently stable rates for the stated conditions and are expressed on a square decimeter stem surface basis.

Table 1. Gas Exchange Measurements on Ocotillo

	Deep Canyon Plants no. 1	Deep Canyon Plants no. 2	Potted Plant
With leaves			
light	—5.23[1]	—6.45	—1.98
dark	+1.11	+0.86	+1.24
Leaves stripped			
light	+0.59	+0.53	+0.54
dark	+1.04	+0.78	+0.90
Bark photosynthesis	—0.45	—0.25	—0.36

[1] Carbon dioxide production or absorption in mg/dm² stem surface/hr.

All plants had bark photosynthetic activity to varying degrees when in a hydrated leafy condition. However, in no instance was bark photosynthesis great enough to attain the compensation point. That is, when hydrated leafless stems were illuminated, carbon dioxide was produced, but to a lesser extent than when the stem was darkened. Bark photosynthesis then is expressed as the difference between carbon dioxide production of illuminated and darkened stems. Bark photosynthesis of the three test plants varied between 0.25 and 0.45 mg CO_2/dm^2 stem surface/hr, a small fraction of the photosynthetic contribution of the leaves.

There was no measurable bark photosynthesis on any of the three plants when they were in a drought-induced leafless condition.

The chlorophyllous bark tissue of ocotillo was found to be photosynthetically active when plants were in a non-drought condition. However, even during such periods of photosynthetic activity, compensation was never attained under the test conditions. Bark photosynthesis, therefore, probably contributes little to the overall seasonal photosynthetic economy of the plant. This small contribution, however, may be of some survival significance.

Scott (1932) presumed that the rapid leaf development of ocotillo after rain depends upon efficient water conduction and high meristematic activity, the latter implying a readily available respiratory substrate. Bark photosynthetic activity subsequent to precipitation may be of some importance in maintaining localized substrates utilized in leaf production. Knowledge of the precise adaptive significance of bark photosynthesis, if any, awaits more detailed studies.

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REVIEWS

The Quiet Crisis. By STEWART L. UDALL. xii + 209 pp, 32 plates. Holt, Rinehart, and Winston, New York. 1963. $5.00.

This should be an influential book in contemporary United States conservation literature. A wide audience is assured by the author's position as Secretary of the Interior, the literary style, the brevity, the biographical approach, and the fresh insights into the history and future of the conservation movement in America.

The contrast between the American Indian's land ethic and that of the white settler is vividly protrayed. Gradually and sporadically a different set of values gained a toehold, with naturalists as the Bartrams and Audubon, the historian Parkman, and the philosophers, Emerson and Thoreau. George Perkins Marsh, and his international classic, *Man and Nature,* is given full credit as the intellectual "fountainhead of the conservation movement." It is a rewarding feature of this book that these men who had little immediate practical influence on conservation are accorded nearly as much space as those later "men of action" who usually dominate United States conservation treatises.

But "The Raid on Resources" had just begun, based on the "Myth of Superabundance," and expedited by the "Great Giveaway" of land as a federal policy. Men of action were needed, and their strengths and weaknesses are succinctly evaluated: Schurz and Powell, Pinchot and Muir, Mather and the two Roosevelts, Olmstead and Rockefeller. Curiously, Hugh Bennett and the Soil Conservation Service is accorded only eight lines, a neglect perhaps accounted for by the fact that the research staff of the Department of Interior, who are acknowledged by the author as collaborators, timidly avoided crossing departmental lines to cover Department of Agriculture affairs.

Unusual emphasis for volumes of this sort is afforded the role of the private foundation, city planning, and the importance of wilderness. The approach in general is aesthetic and biographical rather than ecological and technical. The author's acknowledgements to the works of Leopold, DeVoto, Krutch, Stegner, Atkinson, and Mumford, and his relatively full treatment of the naturalists and philosophers, clearly show a recognition of non-material as well as material benefits of conservation philosophy This emphasis serves to counterbalance that powerful segment of the present schizoid conservation movement which desires nothing more than a continuous sheet of highly productive crops, hybrid trees, or cows over a fully domesticated and manicured earth's surface. The controversy, described by Udall, which developed between Pinchot and Muir on this issue continues unabated today, as shown by current debate on the Wilderness Bill in Congress. Possibly this point could have been given more than an aesthetic foundation alone by incorporating more ecology —